Effects of Sea Spray on the Thermodynamics of the Hurricane Boundary Layer

Research Highlight

The effects of sea spray on surface fluxes under strong winds is usually attributed to surface layer dynamics in the vicinity of the ocean surface. We propose that the main effects of sea spray on surface fluxes and intensity of hurricanes are related to the microphysical effects of spray drops penetrating deep convective clouds in the eyewall of hurricanes.

Convective rolls or large eddies (LE) are typical phenomena within the hurricane boundary layer (HBL). In this study, the effects of LE on the microphysics and thermodynamics of the HBL is investigated using a two-dimensional (2D) Lagrangian model with spectral bin microphysics including the effects of sea spray. The 600 m x 400 m HBL computational area is covered by 3750 adjacent, interacting Lagrangian parcels moving in a turbulent-like flow. The model explicitly calculates diffusion growth/evaporation, collisions, and sedimentation of droplets forming both as sea spray droplets and from background aerosols, as well as aerosol masses within droplets. Sea spray generation is determined by a source function that depends on background wind speed. Non-local mixing of the HBL caused by LE leads to the formation of a well-mixed HBL with a vertical structure close to the observed one. LE leads to a 50–100 percent increase in sensible and latent heat surface fluxes, and transports a significant amount of spray droplets with radii of up to 300 microns upward to altitudes of 350-400 m; that is, higher than the cloud base height of convective clouds in the tropical cyclone (TC) eyewall.

Figure 1 shows the mass distribution M(r) and the number size distribution N(r) of drops at elevations of 100 m, 200 m and 350 m, and at wind speeds of 23 m/s, 29 m/s and 41 m/s. The calculated distributions were approximated by a sum of three-modal log-normal distribution functions. Parameters of the modes were tabulated. The lookup tables will be used for an investigation of sea-spray effects on convection in the TC eyewall and on TC intensity.

Large eddies in the hurricane boundary layer are able to transport large sea spray droplets to the base of deep convective clouds in hurricanes and affect their microphysics.

The size distributions of droplets in HBL are parameterized and tabulated.

These results will be used for investigation of effects of sea spray on deep tropical convection and TC intensity.

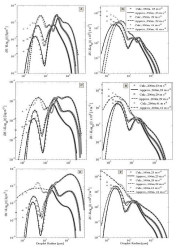

Figure 1. The mass distribution M(r) and the number size distribution N(r) of drops at elevations of 100 m, 200 m and 350 m, and at wind speeds of 23 m/s, 29 m/s and 41 m/s.

Reference(s)

Shpund J, JA Zhang, M Pinksy, and A Khain. 2014. "Microphysical structure of the marine boundary layer under strong wind and sea spray formation as seen from a 2D explicit microphysical model. Part III: Parameterization of height-dependent droplet size distribution." Journal of the Atmospheric Sciences, 71(6), http://dx.doi.org/10.1175/JAS-D-12-0201.1.

Contributors

Alexander Khain, *The Hebrew University of Jerusalem*

Working Group(s)

Cloud-Aerosol-Precipitation Interactions